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Modelling and analysis of convergent divergent nozzle with sudden expansion duct using finite element method (Article)

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Abstract

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In most of the engineering problems, the sudden expansion at the base is encountered in automobile industries, at the base of the fuselage of the aircraft, at the base of the artillery shells, at the base of the unguided rockets and missiles. At transonic Mach numbers, the contribution of the base drag is more than sixty percent. Hence it is mandatory on the part of the researcher to control the base pressure, depending upon the situation. For external aerodynamics, the base pressure should be closed to the ambient pressure to make base drag almost zero. However, for combustion chambers, the base pressure should be very low so that fuel-air mixing is so that the combustor is efficient. With this idea in mind, this study was undertaken. A finite element (FE) method has been used to investigate the effectiveness of the microjets on wall pressure distribution in a convergent-divergent (CD) nozzle with sudden expansion. For control of the base pressure, four microjets of 1 mm orifice diameter placed at 90-degree intervals along a pitch circle distance (PCD) of 1.3 in the base region were used as a control mechanism. The variables considered are the Mach number, area ratio, and length-to-diameter ratio (L/D) as 2.2, 2.56, and 8. The simulation was done for nozzle pressure ratio (NPR) 3, 5, 7, 9, and 11 with and without the presence of the microjets. The current results for all the cases of this study indicate that one can identify the Mach number, NPR, and the L/D, which will result in a maximum increase in the pressure. Moreover, the results also proved that the influence of microjet control does not affect the flow field in the duct adversely. The two-dimensional planar CD nozzle with sudden expansion duct has been modelled, and analyses using the K-ε turbulence model independently checked with the ANSYS tool. © 2019 PENERBIT AKADEMIA BARU.

SciVal Topic Prominence

Topic: Nozzles | Mach number | Suddenly expanded

Prominence percentile: 63.870

Author keywords

Base Pressure | L/D ratio | Mach number | NPR | Wall Pressure

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